Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2188883195

CO-ORDINATED SCIENCES **0973/31**

Paper 3 Theory (Core) **May/June 2021**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **28** pages. Any blank pages are indicated.

DC (CE/SG) 213549

[Turn over

1 **(a)** Fig. 1.1 is a diagram of the human gas exchange system.

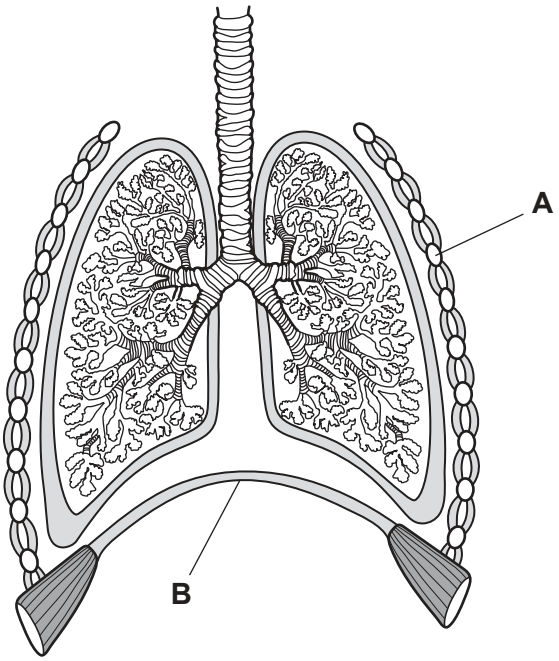

Fig. 1.1

(i) Identify the parts labelled **A** and **B** in Fig. 1.1.

A .....

B .....

[2]

(ii) List **three** structures inspired air passes through on its way to the alveoli.

1 .....

2 .....

3 .....

[3]

(iii) Place a tick (✓) in the box to show the blood vessel that brings blood to the lungs.

aorta	
pulmonary artery	
pulmonary vein	
vena cava	

[1]

(b) Expired air contains a higher percentage of carbon dioxide than inspired air.

(i) State one other way that the composition of expired air is different from inspired air.

.....

..... [1]

(ii) State the test for carbon dioxide gas and give the observation for a positive result.

test .....

observation .....
[2]

(c) A student records their breathing rate while walking and while running.

The results are shown in Fig. 1.2.

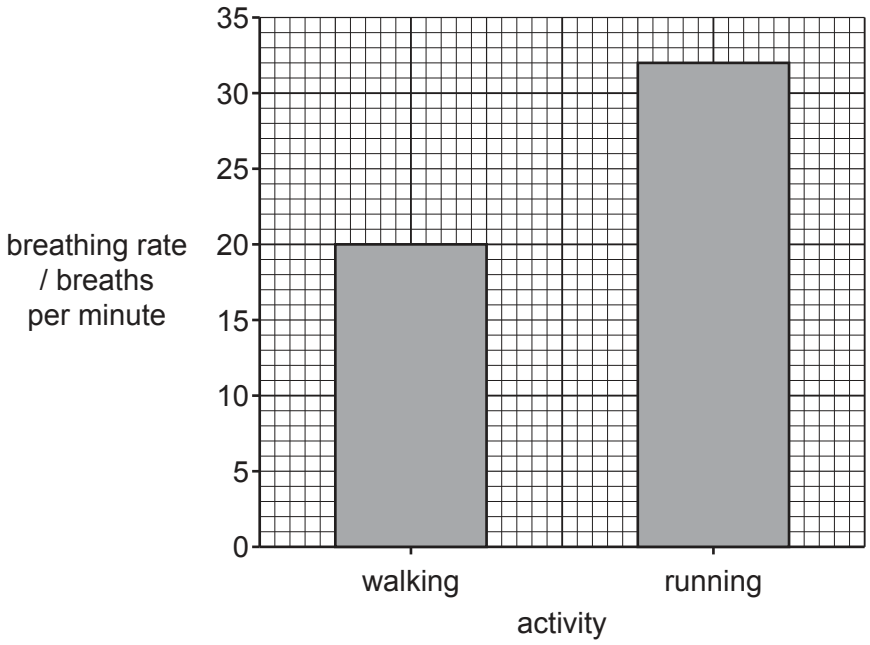

Fig. 1.2

(i) State the breathing rate of the student while walking.

..... breaths per minute [1]

(ii) The student repeats the investigation and records the breathing rate while at rest.

Describe the expected changes to the pattern of breathing while at rest when compared to running.

.....

.....

..... [2]

[Total: 12]

2 **(a)** Table 2.1 shows information about three Group VII elements.

Table 2.1

element	formula	colour	physical state at 20 °C
chlorine	Cl_2		gas
bromine		orange	
iodine	I_2	grey	

(i) Complete Table 2.1. [3]

(ii) State the name given to the Group VII elements in the Periodic Table.

..... [1]

(b) Bromine reacts with hydrogen to make hydrogen bromide.

Construct the word equation for this reaction.

..... + ... → ..... [1]

(c) Aqueous bromine is orange.

Predict the colour change, if any, when aqueous bromine is mixed with ethene gas.

Explain your answer.

colour change .....

explanation .....

.....

[2]

(d) An aqueous solution is tested to see if bromide ions are present.

State the test for aqueous bromide ions and give the observation for a positive result.

test .....

observation .....

[2]

(e) Fig. 2.1 shows the electrolysis of molten lead(II) bromide using inert electrodes.

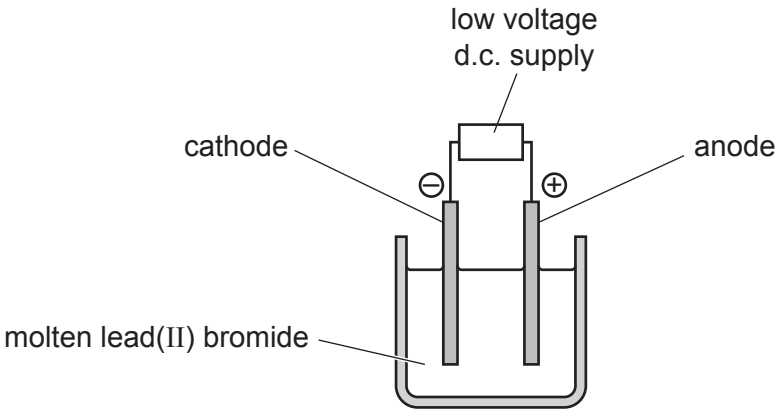

Fig. 2.1

Identify the substances formed at the cathode and the anode.

at cathode .....

at anode .....

[2]

[Total: 11]

3 **(a)** A cyclist starts from rest and accelerates for 20 s.

The cyclist then travels at a constant speed of 5 m / s for 90 s.

Finally the cyclist slows down and stops after a further 5 s.

(i) On the grid in Fig. 3.1 draw a speed-time graph for the cyclist's journey.

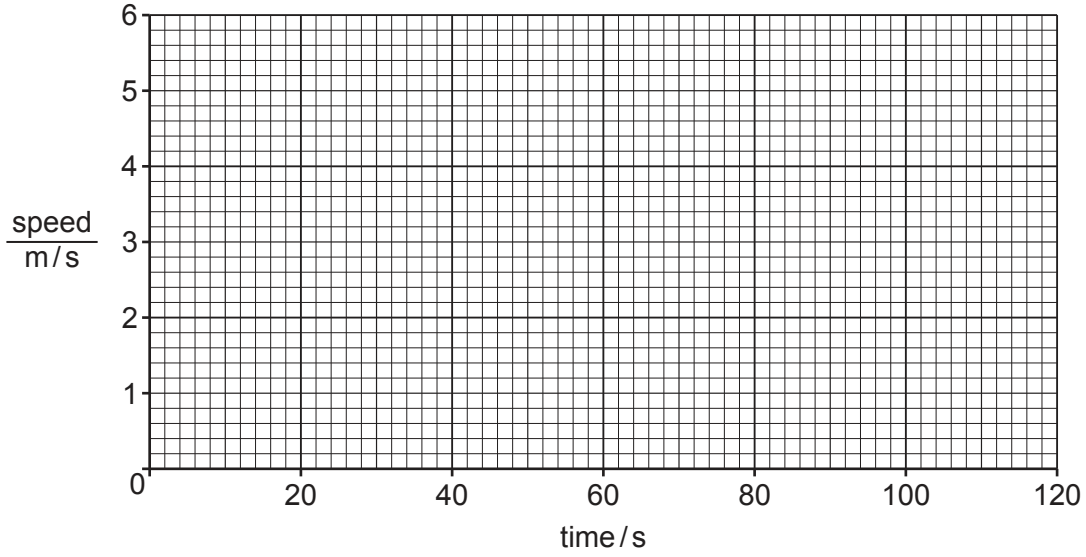

Fig. 3.1 [3]

(ii) Calculate the distance travelled when the cyclist is travelling at constant speed.

distance = ... m [2]

(b) Energy from the Sun heats the black saddle of the bicycle.

(i) State the method of energy transfer between the Sun and the Earth.

..... [1]

(ii) Name the part of the Sun's electromagnetic spectrum that is responsible for heating the saddle.

..... [1]

(iii) The Sun also heats up the air in the bicycle tyres. This causes the pressure of the air in the tyres to increase.

Describe, in terms of the motion of the air molecules, why the pressure of the air in the tyres increases as the temperature of the air increases.

.....

.....

.....

..... [2]

(c) Fig. 3.2 shows a metal nut on the bicycle which is difficult to unscrew.

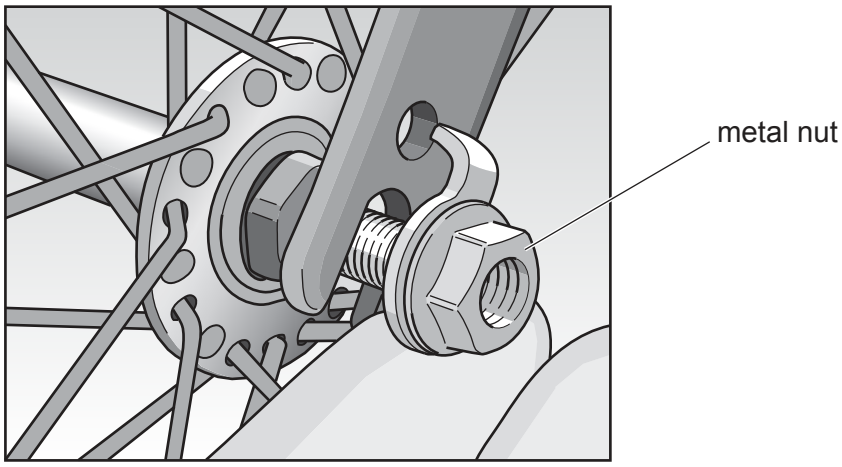

Fig. 3.2

Fig. 3.3 shows two spanners **A** and **B**.

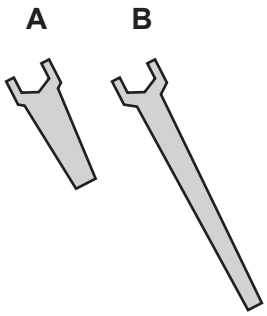

Fig. 3.3

Explain why it is easier to use spanner **B** to unscrew the nut rather than spanner **A**.

.....

.....

..... [2]

(d) The cyclist uses a plane mirror placed on his bicycle to see behind him.

State two characteristics of an image seen in a plane mirror.

1 .....

2 .....
[2]

[Total: 13]

4 **(a)** Fig. 4.1 shows some information about feeding relationships in a national park.

- Lions are the top predator. Lions eat jackals.
- Goats eat grass.
- Goats are eaten by jackals.

Fig. 4.1

(i) Use the information in Fig. 4.1 to construct a food chain containing all the organisms.

[2]

(ii) Use the information in Fig. 4.1 to identify the:

producer .....

secondary consumer. .....
[2]

(b) State the principal source of energy for all food chains.

..... [1]

(c) Table 4.1 shows the number and types of teeth for goats and humans.

Table 4.1

type of teeth	number in goats	number in humans
incisors	8	8
canines	0	4
premolars	12	8
molars	12	12

(i) Goats have a greater total number of premolar and molar teeth than humans.

Describe two other differences between the types and number of teeth in goats and humans.

1 .....

.....

2 .....

.....
[2]

(ii) Goats are herbivores. Humans are able to gain their energy by eating both animals and plants.

Suggest reasons why goats have a greater total number of premolar and molar teeth than humans.

.....

.....

..... [2]

(iii) Circle the **top two** layers in a human tooth.

cement **dentine** **enamel**

gum **pulp** **nerve**

[2]

[Total: 11]

5 **(a)** Table 5.1 shows information about four metallic elements.

Table 5.1

metal	reaction of metal with water
copper	does not react with water
iron	reacts very slowly with water
lithium	reacts rapidly with water
sodium	reacts very rapidly with water

(i) State the names of the two metals in Table 5.1 that are transition elements.

..... and ..... [1]

(ii) Suggest the name of the gas produced when an alkali metal reacts with water.

..... [1]

(iii) Place the four metals in order of reactivity from the most reactive to the least reactive.

..... most reactive

↓

.....

.....

..... least reactive [2]

(b) Copper is extracted by heating copper oxide with carbon.

The word equation for the reaction is shown.

copper oxide + carbon → copper + carbon dioxide

(i) Balance the symbol equation for this reaction.

.....CuO + C → .....Cu + CO_2 [1]

(ii) Identify which substance is reduced during this reaction.

Explain your answer.

substance reduced .....

explanation .....

[2]

(c) During the extraction of copper, carbon dioxide is released into the air.

Carbon dioxide is found in small quantities in clean air.

(i) State the names of the two gases which are found in large quantities in clean air.

..... and ..... [1]

(ii) Carbon dioxide is a greenhouse gas.

State the name of one other greenhouse gas.

..... [1]

(iii) Carbon dioxide is released into the air during the combustion of fossil fuels.

State the names of two fossil fuels.

..... and ..... [1]

[Total: 10]

6 **(a)** A car has two identical headlamps. The lamps are connected in parallel across a 12 V battery. A single switch is used to turn on both lamps.

(i) Draw a circuit diagram for this circuit using standard electrical symbols.

[3]

(ii) The resistance of each lamp is 3.0 Ω.

Calculate the current in each lamp when lit.

current = ...A [2]

(iii) State one reason why the lamps are connected in parallel and not in series.

.....

..... [1]

(b) A lamp consists of a glass bulb, which contains a thin metal filament attached to a metal base.

The glass bulb is filled with nitrogen gas.

When electricity passes through the lamp, the filament is at a very high temperature.

Fig. 6.1 shows a lamp.

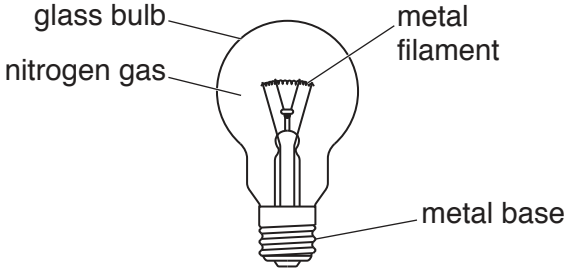

Fig. 6.1

Thermal energy is transferred from the hot filament through the nitrogen gas and through the glass bulb.

State the method by which thermal energy is transferred:

(i) by the nitrogen gas to the glass bulb

..... [1]

(ii) through the glass bulb.

..... [1]

(c) On a journey, a car becomes electrostatically charged.

Describe what happens to cause the car to become charged.

.....

.....

..... [2]

(d) Fig. 6.2 shows how damage to a steel door of the car has been repaired with a plastic filler. The filler has been painted over and cannot be seen.

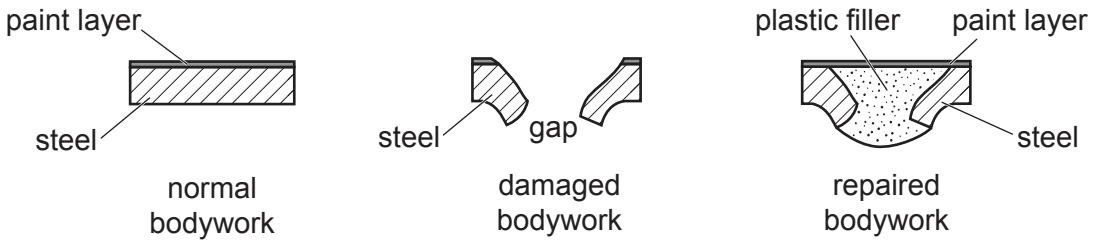

Fig. 6.2

Suggest how the owner of the car uses a magnet to detect the repair to the bodywork.

.....

.....

..... [1]

[Total: 11]

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7 **(a)** Table 7.1 shows some of the functions of the main components of blood.

Complete Table 7.1 with the name of the component of blood for each function.

Table 7.1

name of component	function of component
	blood clotting
	oxygen transport
	phagocytosis and antibody production
	used for transport of hormones

[4]

(b) Some of the substances transported by the blood need to be excreted.

The boxes contain the beginnings and the endings of some sentences.

Join **one** sentence beginning to **one** sentence ending to define the term excretion.

beginning	**ending**
Excretion is the absorption and assimilation of	non-toxic materials only.
Excretion is the digestion of	substances in excess of requirements only.
Excretion is the removal from organisms of	toxic materials and substances in excess of requirements.
Excretion is the taking in to organisms of	toxic materials and substances required by the body.

[2]

(c) Excretion, respiration and nutrition are three characteristics of living organisms.

Name two other characteristics of living organisms.

1 .....

2 .....

[2]

[Total: 8]

8 **(a)** Fig. 8.1 shows three molecules **A**, **B** and **C**.

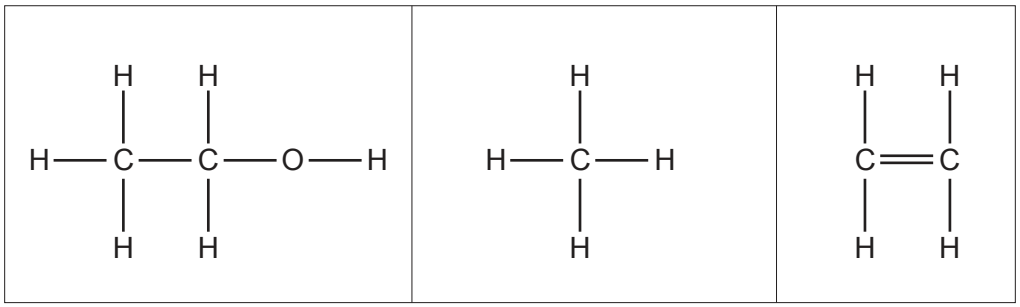

Fig. 8.1

State the formula of the substance that reacts with molecule **C** to make molecule **A**.

..... [1]

(b) Molecule **B**, CH_4, is methane which is a compound. Methane contains the elements carbon and hydrogen.

Use this information to explain the difference between an element and a compound.

.....

.....

..... [2]

(c) State the two products made when methane undergoes complete combustion in oxygen.

1 .....

2 .....
[2]

(d) The combustion of methane is an exothermic reaction.

State what is meant by *exothermic*.

.....

..... [1]

(e) An atom of carbon has a nucleon number (mass number) of 12 and a proton number (atomic number) of 6.

An atom of hydrogen has a nucleon number (mass number) of 1 and a proton number (atomic number) of 1.

(i) State the number of electrons in an atom of carbon and in an atom of hydrogen.

carbon .....

hydrogen .....

[1]

(ii) State the number of neutrons in this atom of hydrogen.

..... [1]

(f) Complete the dot-and-cross diagram in Fig. 8.2 to show the bonding in a methane, CH_4, molecule.

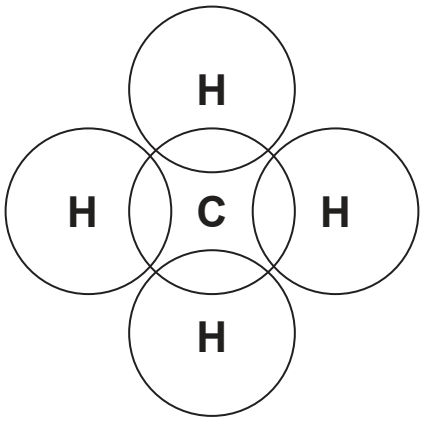

Fig. 8.2

[2]

[Total: 10]

9 **(a)** A school orchestra is practising.

Table 9.1 shows the highest and lowest sound frequencies of some of the musical instruments in the orchestra.

Table 9.1

instrument	highest frequency / Hz	lowest frequency / Hz
flute	2600	260
guitar	1200	70
piano	4200	30
violin	3500	200

(i) State what is meant by the *frequency* of a wave.

.....

..... [1]

(ii) State which instrument in Table 9.1 produces the sound with the lowest pitch.

..... [1]

(iii) State which instrument in Table 9.1 produces sound with the widest range of frequencies.

..... [1]

(iv) State the normal audible frequency range for a healthy human ear.

from ..... Hz to ..... Hz [1]

(b) A flute is made from a nickel alloy. The volume of the alloy used to make the flute is 90 cm^3.

The mass of the flute is 801 g.

(i) Calculate the density of the alloy.

State the unit of your answer.

density = ... unit ..... [3]

(ii) Calculate the weight of the flute.

The gravitational field strength *g* is 10 N / kg.

weight = ... N [2]

[Total: 9]

10 **(a)** Plants use different tissues to transport substances around the plant.

Circle **two** parts of a plant that are adapted for transport.

capillaries **chloroplasts** **fatty tissue** **guard cells**

phloem **vena cava** **xylem**

[2]

(b) Fig. 10.1 is a diagram of a plant cell.

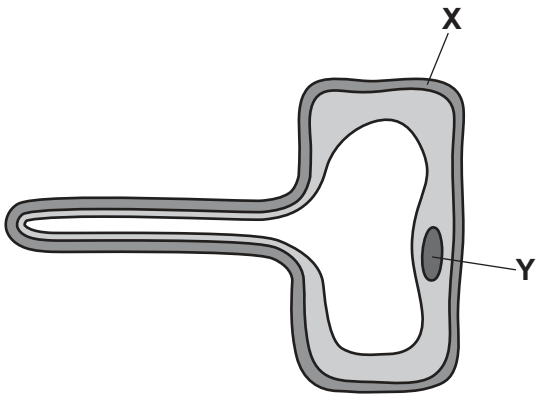

Fig. 10.1

(i) Name the cell shown in Fig. 10.1 and state its function.

name .....

function .....

.....

[2]

(ii) Identify the parts labelled **X** and **Y** in Fig. 10.1.

X .....

Y .....

[2]

(c) A scientist investigates the conditions needed for the germination of seeds.

She sets up four experiments **A**–**D** with different conditions.

Table 10.1 shows the conditions for each experiment.

Place a tick (✓) in Table 10.1 to identify the experiment where the seeds will germinate.

Table 10.1

experiment	temperature / °C	moisture	oxygen	do seeds germinate? (✓)
A	–20	damp	present	
B	–20	dry	absent	
C	20	damp	present	
D	20	dry	absent	

[1]

(d) Germination is an enzyme-controlled reaction.

The investigation is repeated with boiled seeds.

Describe the effect of boiling on the germination of seeds.

Give one reason for your answer.

effect .....

reason .....

.....

[2]

[Total: 9]

11 **(a)** Fig. 11.1 shows iron rusting.

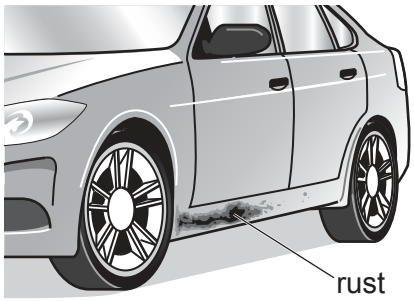

Fig. 11.1

(i) Iron rusts when two other substances are present.

State the names of these two substances.

..... and ..... [2]

(ii) Describe **and** explain one method used to prevent the rusting of iron.

.....

.....

..... [2]

(b) Stainless steel is an alloy of iron.

State one use for stainless steel.

..... [1]

(c) Solid iron melts at 1538 °C to become liquid (molten) iron.

Describe one difference in the properties of a solid compared to a liquid.

.....

..... [1]

(d) Melting is one of the processes involved when a substance changes state.

Fig. 11.2 shows other processes involved when substances change state.

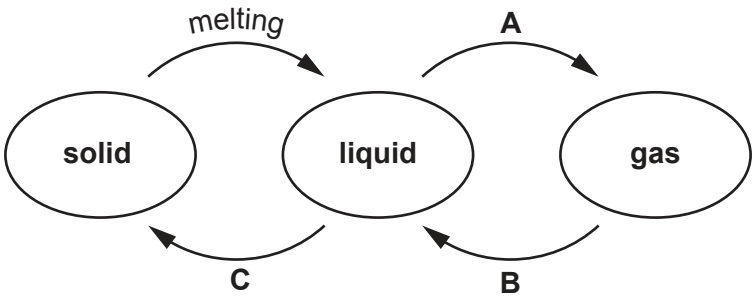

Fig. 11.2

Identify processes **A**, **B** and **C**.

A .....

B .....

C .....

[3]

[Total: 9]

12 **(a)** Describe how to show that a radioactive isotope is releasing γ-rays but not α-particles or β-particles.

.....

.....

.....

.....

..... [2]

(b) In a nuclear reactor the fission of uranium-235 takes place.

(i) Describe what happens to the nucleus of a uranium-235 atom during nuclear fission.

..... [1]

(ii) The half-life of uranium-235 is 704 million years.

A sample of uranium-235 has a mass of 0.1 g.

Calculate how many grams of uranium-235 will remain in the sample after 704 million years.

mass of uranium-235 remaining = ... g [1]

(iii) Uranium-235 and uranium-238 are two isotopes of uranium.

Explain what is meant by *isotope*.

.....

.....

..... [1]

(c) A nuclear power station generates electricity. One use of electricity is to power an electric motor.

In a d.c. electric motor, a current-carrying coil in a magnetic field experiences a turning effect.

State two factors that can be changed to increase the turning effect in a d.c. motor.

1 .....

2 .....
[2]

[Total: 7]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).